MATHEMATICS

Paper 9794/01

Pure Mathematics 1

Key messages

One key message from this year's paper is to stress the need for candidates to state a deduction from their results with precision and care. A second key message is that the use of graph paper is neither necessary nor desirable when candidates are requested only to provide a sketch of a graph.

General comments

Almost all candidates had a high standard of presentation of their answers and care was taken to provide fully argued and detailed responses to the questions asked. All candidates displayed a secure knowledge of the syllabus, and many achieved a commendably high standard. However, greater care should be exercised by many in expressing their results, both in the context of formal argument and in algebraic notation. For example, an inconsistency within a system of simultaneous equations does not show that the lines in three dimensional space represented by those equations are necessarily skew, only that they do not intersect.

Comments on specific questions

Question 1

This first question attracted almost universally correct responses, although candidates should take care to give the final answer in the form requested.

Answer: $y = -\frac{1}{5}x + \frac{56}{5}$

Question 2

This question also received almost universally correct responses and it was pleasing to note that there was no evidence that short cuts had been taken with a calculator.

Answers: **(i)** $8\sqrt{5}$ **(ii)** $15\sqrt{5}$

Question 3

Candidates had little difficulty in locating the critical values for this inequality. A sizeable number however, then experienced difficulty in stating the correct range of values. It is important for candidates to realise that if they arrive at a wrong answer and do not provide the Examiner with any evidence of the method they have used to obtain it, they lose both method and accuracy marks. A sketch of the quadratic showing the critical values is sufficient to indicate a convincing method but, in this question, the problem was compounded by the fact that candidates also took less than ideal care in notation. Set notation is not necessarily expected, but ranges need to be specified accurately. The minimum standard acceptable in this regard is two ranges separated by a comma, e.g. $x < -5$, $x > \frac{4}{3}$ although this is hardly ideal. What is unacceptable is the use of a wrong connector or separate ranges condensed by using a single inequality, e.g. $-5 > x > \frac{4}{3}$

Answer: $x < -5$ or $x > \frac{4}{3}$

Question 4

An excellent set of answers was given by all but a handful of candidates. Where any difficulty tended to arise was in interpreting the summation sign in part **(iii)** and realising that this entailed the use of the sum of an arithmetic progression.

Answers: **(i)** 8, 11, 14. **(ii)** 83 **(iii)** 378 250.

Question 5

This is the first question on the paper which caused candidates substantial difficulty. Almost all candidates gave correctly the coordinates of the centre of the circle but then many were unable to relate the form of the equation given to the standard equation of the circle to achieve a meaningful equation in k. Wrong values like 34 and –16 abounded but it may be pertinent to reiterate at this juncture that a wrong answer with no method seen must lose not only the accuracy mark but also any method mark. Those who at least obtained an equation containing k, 9 and 25 did show some insight and could be rewarded accordingly.

Answers: (3, 0), $k = 16$

Question 6

Performance on this question was predictably good. Three caveats must be made however. Candidates who attempt to solve equations by cancelling factors rather than factorising them lose not only roots but cannot achieve full credit for their answer. This was particularly so in this question where the loss of $x = 0$ as a root meant that the nature of the root could not be determined nor a correct sketch of the graph achieved so the loss of marks was grievous. The second caveat concerned the sketch of the graph. Those candidates who made a true sketch of the graph on the examination paper in the booklet achieved far better results than those who used graph paper on which scales were used which not only looked absurd but gave a totally false impression of a quartic curve. The third caveat applied only to a minority of candidates who tried to indicate the nature of the stationary points by indicating only the sign of the second or first derivative at chosen points. Examiners required to see the relevant coordinate substituted into the derivatives and evaluated. The reason is clear. A quartic curve is not a strange one so merely quoting the sign expected of a derivative showed no attempt to relate this knowledge to the given curve. On the other hand, Examiners accepted just the result of the evaluations without evidence of substitution provided that these were correct. In the final part, Examiners reported that many candidates were able to specify a correct set of values of k, although some spoilt their attempt by inclusion of the equality.

Answers: **(i)** (0, 0) minimum, (2, 32) maximum, (3, 27) minimum **(ii)** $27 < k < 32$

Question 7

Performance on the first two parts of this question indicated a very good level of understanding by a majority of candidates. Candidates who in **question 6** used a cancellation instead of a factorisation approach tended to repeat this here with the loss of a root and another consequent loss of marks. Part **(iii)** however, provided a very significant challenge to candidates in understanding what was required. A very large majority believed the request was for the domain of h^{-1} instead of the domain of h. This was doubly unfortunate as many provided an expression for $h^{-1}(x)$ but, as this very much depended on the domain specified, no credit could be awarded for this. There were also those who correctly specified the range of f as $f(x) \geq 2$ but omitted to include the 0 in specifying the domain for h.

Answers: **(i)** $f(x) \geq 2$, Range of g is all real numbers **(ii)** $x = 0, -2$ **(iii)** either $x \geq 0$ and $y = \sqrt{x-2}$ or $x \leq 0$ and $y = -\sqrt{x-2}$

Question 8

The first part of this question was well handled by most candidates although a few did not observe that exact evaluation effectively forbade the use of the calculator. It is a recurring theme that candidates who produce a wrong answer to a definite integral and do not show which limits have been substituted into their integral or how they have been evaluated can be given neither method nor accuracy marks and some candidates fell foul of this truth.

The second part of this question provided an unexpected challenge to a large number of candidates but Examiners saw a number of ingenious responses to it. The methods Examiners considered the most obvious were to use a reverse substitution method or division to obtain $1 - \dfrac{2}{x+1}$. There were however, some excellent innovative approaches in which division was avoided by using the addition of constants constructively, e.g. $\dfrac{x+1-1-1}{x+1}$ to achieve the same result. Unfortunately, some candidates attempted parts directly but came adrift when faced with $\int \ln(x+1)\,\mathrm{d}x$. Some candidates continued this approach through to fruition but it was unfortunate that a more concise solution method was missed. Finally, there was a lack of care in using modulus signs in work with the ln function and the occasional omission of the arbitrary constant.

Answers: **(i)** $1 - \dfrac{2}{\mathrm{e}}$ **(iii)** $x - 2\ln|x+1| + c$

Question 9

This question was poorly answered by many. The necessary care in presenting an argument was often missing. For example, to assert that a set of inconsistent equations demonstrated that the lines they represented were skew without also discarding the fact that they might be parallel lost many marks. However, it was observed that almost all candidates were aware of the basic strategy for demonstrating a set of inconsistent equations but to use a substitution method for solving simultaneous equations when this involves dealing with not easy fractions is asking for error. In this question, any error in finding the values of the parameters is fairly fatal since arguments around inconsistency are only valid if based on correct values in the first place. A lack of care was also demonstrated when asserting correctly that the lines were not parallel. Mention of direction vectors not being multiples of each other require them to be shown explicitly. This is the more evident when some candidates make the same assertion but show the position vectors of the point on the line, or the whole line equation to substantiate their claim.

Question 10

Very many impressive attempts were seen in answering this question. In part **(i)** the error most frequently seen was the omission of the constant in applying the chain rule but a minority of candidates approached the task in a far more complex way than envisaged by embarking on implicit differentiation. To produce the expression $1 = \dfrac{\mathrm{d}y}{\mathrm{d}x}(\ln(2y+3)) + \dfrac{(y-4)\dfrac{2\mathrm{d}y}{\mathrm{d}x}}{2y+3}$ was immensely impressive but unnecessary. Many candidates negotiated their way successfully through part **(ii)**. However, candidates must be aware that wrong answers without any working display no method for achieving them so neither method nor accuracy marks are available. Examiners made one exception however to this rule. Candidates who gave answers of −10 and ln11 were felt to have implied a correct method even though they had not completed the answer by finding the reciprocals.

Answers: **(i)** $\ln(2y+3) + \dfrac{2(y-4)}{2y+3}$ **(ii)** -0.1, $\dfrac{1}{\ln 11}$.

Question 11

This question proved a substantial challenge to many candidates although the best candidates impressed by the sureness of their proof and their manipulative ability in achieving the correct equation to solve. While most candidates correctly stated the identity $\sin\left(\theta+\frac{\pi}{3}\right)=\sin\theta\cos\frac{\pi}{3}+\cos\theta\sin\frac{\pi}{3}$, this was often in the context of expanding the square term by term, so omitting the term in $\cos\theta\sin\theta$ and preventing successful conclusion of the proof. In part **(ii)** manipulating the given equation into a form in which they could arrive at an equation in $\sin 2\theta$ defeated many. Some arrived eventually at $\sin 2\theta=\frac{1}{\sqrt{3}}$ but many appeared to completely omit the $-\frac{3}{4}$ term in their working. The final answers were often incomplete or incorrect in one or more significant figures although the overwhelming majority of candidates observed that their answers were required in radians and not degrees.

Answer: **(ii)** –0.308, 2.83, −1.26, 1.88

Question 12

Many candidates achieved success in this challenging question. Candidates adopted two different approaches in dealing with the rate of decrease. While many set up the differential equation in the form $\frac{\mathrm{d}x}{\mathrm{d}t}=-\frac{k}{\sqrt{x}}$ with k = 0.1, quite a few chose to show that $\frac{\mathrm{d}x}{\mathrm{d}t}=\frac{k}{\sqrt{x}}$ with k = −0.1. Both forms were equally valid but some candidates became confused with the negative signs and seemed to find the correct answer from the equation $\frac{\mathrm{d}x}{\mathrm{d}t}=-\frac{k}{\sqrt{x}}$ with k = −0.1. Less successful candidates included those who omitted k altogether in their equation and little could be done to rescue candidates who interpreted “inversely proportional” to mean “directly proportional”. On the whole, candidates set up and handled the two constants involved in the solution very well.

Answer: 56.3 days

MATHEMATICS

Paper 9794/02
Pure Mathematics 2

Key messages

In order to be successful, candidates must have a good understanding of all areas of the syllabus. They should be able to express themselves clearly, using mathematical conventions, and ensure that when proving a given result they show sufficient detail. When sketch graphs are requested, an accurate plot on graph paper is not required but candidates should ensure that the sketch shows clearly the general shape of the graph and any key points are clearly labelled.

General comments

The majority of candidates were well prepared for this examination, and were able to demonstrate their knowledge. Most candidates could make an attempt at all of the questions, even the more challenging latter questions. Most candidates appreciated the links between various parts of a question, and were able to use previous solutions to make progress on the latter parts. Other candidates need to refine this technique rather than starting anew each time. Many candidates showed clear detail of the methods used in their solutions, but others need to ensure that sufficient detail is provided for every step in a proof in order for it to be fully convincing. When sketching a graph, candidates would be best advised to include this in their answer booklet as it is then more easily referred to than if the graph is drawn on a separate sheet of graph paper.

Comments on specific questions

Question 1

(i) The most straightforward method was to use the remainder theorem, and candidates who used this approach invariably gained full credit. However, candidates who used this method were in a minority and most candidates attempted to use either algebraic long division or inspection. The lack of both an x^2 term and a constant term meant that both of these approaches were not as successful as use of the remainder theorem and often stopped short of an attempt at a numerical remainder. Some candidates did not appreciate the definition of the remainder and gave their final answer as a fraction instead.

(ii) This part of the question was very well answered, with many correct solutions seen. Whilst some candidates appreciated the link between the two parts of the question and could deduce a correct value of k, the more common approach was to apply the factor theorem, even when the remainder theorem had not been used in the first part of the question.

Answers: **(i)** –12 **(ii)** 12

Question 2

This question was very well answered, with many fully correct solutions seen. Most candidates appreciated the need to rearrange the equation before introducing logarithms, although there were also some elegant solutions seen that introduced logarithms as the first step and then used the correct process to isolate the x term in the product. The question did not specify the base of logarithm to be used, so candidates were able to make their own decision. Most candidates used base 10, although this was not always stated explicitly, but base 3 was also used and some candidates used natural logarithms. The majority of candidates appreciated that the solution should be given in an exact form, and duly did so.

Answer: $x = \log_3 \frac{5}{4}$

Question 3

Whilst a number of fully correct solutions were seen, a significant minority of candidates did not seem familiar with the skills being tested in this question. The first two marks were given for a correct linear equation as requested in the question, but even this proved problematical with a number of candidates having an equation that involved y rather than $\log_{10}y$. The process for removing the $\log_{10}$ was usually correct, but sufficient evidence was not always provided in obtaining the given answer.

Answer: $\log_{10}y = 2x + 4$, and then rearrange to given answer

Question 4

(i) Candidates mostly understood the meaning of the modulus sign, and the majority were able to correctly find the modulus of z_1 and the modulus of z_2. Finding the modulus of $z_1 + z_2$ proved to be more challenging, and fewer correct solutions were seen. The better solutions included a clear attempt at the sum of the two complex numbers before then attempting to find the modulus of the result. Candidates who attempted to combine both calculations were usually less successful. The most common error was to include the entire imaginary term in the attempt at Pythagoras' Theorem rather than just the coefficient of i. In order to gain full credit on this question, candidates had to verify the given result; simply stating it was not sufficient. A verification using decimal equivalents was sufficient for full credit, but a few candidates provided some very elegant proofs using surds.

(ii) Candidates could gain the first mark for identifying that the locus would be a circle, and this was invariably correct. Identifying the correct centre proved to be a little more challenging and sign errors were relatively common. Whilst many candidates seemed to appreciate the salient points of the locus, some were unable to clearly demonstrate this with their sketch. To gain full credit, it was required that the y-axis was tangential to the locus and also that the locus did not pass through the point (0, 0). Sketch graphs do not need to be accurate plots, but candidates need to take sufficient care to ensure that their intention is unambiguous.

Answers: **(ii)** circle, with centre 2 + i and radius 2

Question 5

(i) Most candidates gained full credit in this part of the question, with the most common approach being to combine the two fractions using a common denominator. Some candidates started with the single fraction and then used partial fractions to prove the given result; this approach was equally successful.

(ii) A number of candidates appreciated the link between this part of the question and the previous part, and carried out the straightforward differentiation of the two individual fractions. This was nearly always done correctly. Other candidates ignored the link and differentiated the single fraction using the quotient rule. Candidates could make a good attempt at using this rule, but omission of essential brackets sometimes resulted in the final derivative being incorrect.

(iii) A number of elegant and concise proofs were seen in this question, with candidates explaining their reasoning clearly and providing evidence to support their conclusions. Most candidates were aware that, in order to prove it was a decreasing function, they had to show that the gradient was negative. Whilst some did indeed consider the signs of both the numerators and the denominators before concluding that $f'(x)$ was negative, a number of other candidates simply stated that $f'(x)$ was negative with minimal, or no, evidence. Whilst it may seem evident to the candidate, sufficient reasoning has to be provided for full credit to be awarded. Some candidates seemed unaware of the structure of a rigorous proof and simply evaluated $f'(x)$ for several different values of x. Other candidates seemed to be considering the sign of their derivative, but their explanation indicated that they were not entirely familiar with the definition of a decreasing function; the most common misconception was that the gradient should be always decreasing.

Answers: **(ii)** $-\frac{3}{(x+2)^2}-\frac{1}{(x+1)^2}$ **(iii)** demonstrate that $f'(x)$ is negative for all x

Question 6

(i) This question was very well answered with most candidates gaining full marks. The most common approach was to apply the scalar product, and candidates invariably used the correct two direction vectors. Some candidates instead used the cosine rule, and this was also usually correct.

(ii) Most candidates attempted to find the length of the third side of the triangle, and this was usually correct although sufficient evidence was not always provided to justify the result. Other candidates attempted to prove that the triangle was isosceles by considering the other angles. The attempt was usually correct, but only the better solutions showed evidence of working exactly throughout, including use of the exact surd value for cos42°.

Answer: **(i)** 42.0°

Question 7

(i) Candidates appreciated the need to evaluate f(0.7) and f(0.8) and most were able to do this accurately. In an improvement on previous sessions, candidates appreciated the need to have their calculators in radian mode. To gain the second mark, candidates had to conclude appropriately. Most candidates could express their reasoning clearly, either in words or symbols, but a few candidates omitted to offer any evidence for their conclusion.

(ii) The majority of candidates could sketch the two required curves and identify the coordinates of the points of intersection with the axes. In order to gain full credit candidates had to also ensure that the two graphs were in proportion to each other, and this was often not the case. A common error was for the linear graph to actually pass through the point $(\pi/2, 1)$ rather than the required (1, 1), without candidates realising that this had happened. The best solutions had either (1, 1) or $(\pi/2, \pi/2)$ clearly marked as a point on their sketch and then used this to correctly locate the two curves.

(iii) Many candidates could gain the first mark for correctly stating the derivative of $\cos x$, but there was then some uncertainty as to how to use it. The most convincing solutions evaluated the gradient at a point close to the root and then concluded using the correct definition for convergence of the iteration. A number of candidates considered the magnitude of $-\sin x$ over the entire domain, but this often resulted in either $x = \pi/2$ not being specifically excluded, or the condition for convergence not being given as a strict inequality. Some candidates did not appreciate what was required of them, and instead found the root either through using the iterative equation provided or by using the Newton-Raphson method.

(iv) A number of candidates were able to provide diagrams that clearly demonstrated the cobweb convergence of the iteration. The most common error was as a result of the two curves not being drawn in proportion to each other, resulting in gradients that meant that the cobweb actually went in the incorrect direction. Some candidates were either not familiar with this topic, or did not appreciate what the question was asking of them, and simply marked the root on their diagram, sometimes accompanied by a few additional points on $y = \cos x$.

(v) Candidates had some appreciation that they needed to evaluate the function for values of x on either side of the root, but only a minority of candidates were able to identify two relevant values with use of 0.7390 and 0.7392 being the most common error.

Question 8

A number of elegant and concise solutions to this question were seen, with the final answer being given in a variety of different forms. Any exact equivalent was allowed, as long as the final answer was given in terms of θ. Rather than using the cosine rule as expected, a number of candidates instead used either the sine rule or basic trigonometry in a right-angled triangle. Whilst this usually resulted in a correct expression for the arc length, it was in terms of $\frac{1}{2}\theta$ rather than θ as specified in the question. Partial credit was allowed for this solution, and some candidates did continue with the proof to obtain a correct final answer, but the majority did not appreciate that they had not fully answered the question as posed.

Answer: arc length = $\theta\sqrt{\dfrac{8}{1-\cos\theta}}$

Question 9

(i) A number of fully correct and convincing proofs were seen in this part of the question. Most candidates started with the left-hand side and could then attempt a sensible first step in the proof, most typically multiplying the numerator and denominator by $1 - \sin x$. The denominator was then rewritten as $\cos^2 x$ and the proof concluded, more often going via $\tan^2 x$ rather than using an identity in the numerator as well. A number of candidates instead started with the right-hand side, and this was also usually successful although the factorising and cancelling required at the end of the proof eluded some.

(ii) Most candidates appreciated the link with the previous part of the question, although a few attempted to integrate the given rational function. Candidates who were familiar with the List of Formulae were able to simply quote the relevant results, apply the limits and gain full credit with ease, and many fully correct solutions were seen. Other candidates attempted to use integration by parts or integration by substitution on the first term, but this was rarely successful. Credit could still be gained for attempting the correct use of limits in an incorrect integral, and a number of candidates benefited from this. Some candidates just wrote down a numerical answer, which made it impossible to deduce whether or not a correct method had been used. Showing clear detail of the methods used is essential if partial credit is to be awarded. A few candidates simply wrote down the given answer without showing any clear attempt to use limits correctly.

Question 10

(i) This part of the question was generally well answered with many fully correct solutions seen. Most candidates were able to correctly link du and dx, and then attempt to use this to obtain an integrand in terms of u only. This sometimes resulted in sign errors, and poor manipulation of the indices could result in u^4 or u^{-4} being present, which limited further progress. Some candidates spoiled an otherwise correct solution by not giving their final answer in terms of x, or by omitting the constant of integration.

(ii) Candidates who had obtained the correct integral in part **(i)** invariably gained full marks in this part of the question, with use of x limits or u limits being an equally common approach. A mark was available for correct use of limits, and this was often gained by candidates with the incorrect integral as long as sufficient detail of their method had been shown.

(iii) To gain full credit in this question, candidates had to provide a convincing proof as to why only two values were possible and also clearly distinguish between the two cases by considering odd and even values of n in general terms. A number of fully convincing solutions were seen, but these were in the minority with many candidates not providing sufficient evidence of their reasoning. Attempting to establish a general result by considering a few numerical examples did not gain any credit, and candidates should appreciate that more rigour is required in questions of this nature.

Answers: **(i)** $\cos\left(\dfrac{1}{x}\right) + c$ **(ii)** –2, 2 **(iii)** prove that the integral is 2 if n even, and –2 if n odd

Question 11

(a) Most candidates seemed aware of the required process, and could form a correct expression for the gradient of the chord. A number of candidates were then able to identify the next step in the proof, with use of the difference of two squares being a much more common approach than using the result of a binomial expansion. These candidates would then nearly always complete the proof with sufficient detail. There were however a number of candidates who could make no further progress beyond the expression for the gradient of the chord.

(b)(i) This proved to be a suitably challenging finish to the paper and only the most able candidates were able to provide a complete and convincing proof. Even establishing the equations of the tangents was found to be challenging. The best solutions used $y - y_1 = m(x - x_1)$, and then addressed the denominator in the gradient. Attempting to use $y = mx + c$ to find an expression for c was generally less successful. Candidates generally appreciated the need to make x the subject of the equation by taking it out as a common factor, but the algebraic manipulation was not always done accurately, and some candidates did not provide sufficient justification for the appearance of the final answer.

(ii) A number of candidates were able to gain at least one mark on this question by suggesting a pair of values that gave at least one integer coordinate, and many candidates gained full credit. The most common errors were to suggest a pair of values that did not give an integer value for the *y*-coordinate or to suggest a pair of values where $a = b$. Some candidates made no attempt at this final part of the question, either because they had spent too long on the previous part of the question or because they did not appreciate that they would still be able to make an attempt at it by using the previous given answer.

Answers: **(a)** prove $f'(x) = 0.5x^{-0.5}$ from first principles **(b)(ii)** e.g. $a = 4$, $b = 16$

MATHEMATICS

Paper 9794/03
Applications of Mathematics

Key messages

For all topics that could be tested within this paper, but especially in the Mechanics section, it is important to have a clear understanding of the modelling principles that should be applied to the context or situation in the question. The best responses always begin with statements, preferably referenced, that show, in a straightforward manner, the application of those principles. A particular case in point would be any question that involves the use of Newton's Second Law, where careful application and use of notation should remove any apparent need to adjust or ignore, for example, signs that turn out to be not what was required or inconvenient.

General comments

This paper appeared to have been well received by candidates and there were many high scoring scripts. There was no evidence to suggest that candidates were short of time. On the whole the Probability and Mechanics Sections appeared to be equally accessible to most candidates. Candidates are reminded that, when considering the accuracy of final answers, they should bear in mind the context of the problem and/or the consequences of premature approximation. It is reasonable to expect candidates at this level to know certain simple Pythagorean triples and their use with trigonometrical functions without needing to use their calculators.

Comments on specific questions

Section A: Probability

Question 1

This question was usually well answered by candidates. By and large there was evidence of good, appropriate use of the statistical functions of the calculator. When asked to 'Show' an answer that is given in the question, candidates need to understand that this means there is an even greater need to show clear and convincing working and, in cases such as this, sight of the unrounded answer is absolutely essential.

Question 2

(i) This part was answered easily by very many candidates. As in previous years there were a few issues to do with premature approximation of the *z*-value prior to looking up the probability in the tables. Candidates should normally expect to have to use the difference columns in the tables, and if it is clear that they have not done so then they cannot expect to earn full credit.

(ii) There were very many correct answers to this part too. When full marks were not awarded it was often because of mistakes made looking up the correct critical value. Candidates are reminded that, at the foot of page 18 of the formula booklet, there is a list of the common critical values from which they can quote, and so there should not normally be any need to attempt to read (and interpolate) the normal distribution table backwards.

Answers: **(i)** 0.1457 **(ii)** 1.65

Question 3

(i) One way or another most candidates were able to find the new mean correctly but the new standard deviation posed much more of a challenge. It is expected that candidates will have a far greater familiarity with the formula for standard deviation, including its rearrangement to find Σx^2, than was evident from their responses.

(ii) As in part **(i)** the correct value of the mean was often obtained but the standard deviation eluded most candidates. It seemed clear that few candidates were familiar with linear coding of data and how to obtain the mean and standard deviation of one variable from the mean and standard deviation of the other using the linear relationship. Furthermore, the context of this part of the question was about money so, while the mean came to a whole number of pounds, it is reasonable to expect the standard deviation to be quoted to the nearest penny.

Answers: **(i)** Mean 0.72, s.d. 0.873 **(ii)** Mean £83, s.d. £21.83

Question 4

(i) There were very many correct answers for all three probabilities in this part. It continues to be the case that candidates prefer to calculate binomial probabilities using the formula rather than the tables in the formula book. In part **(a)**, candidates (and there were many) who worked out and summed the individual probabilities of 0, 1, 2 and 3 blue sweets might reflect on the amount of work they had to undertake for just 1 mark, especially compared to the next part of the question where the probability of just 3 blue sweets earned 2 marks. In part **(c)** the use of '$1 - 0.8^{10}$' seemed to provide a good basis for what would come next in part **(ii)**.

(ii) Again there were many good answers to this part; it seemed that candidates were well prepared for a question of this sort. Two approaches were possible: solving $0.8^n \le 0.05$ using logs was by far the more popular and successful. A trial and error approach is also quite acceptable, but it is important to realise that trials of consecutive values of *n* that straddle the condition are needed to be certain of the result.

Answers: **(i)(a)** 0.8791 **(i)(b)** 0.2013 **(i)(c)** 0.8926 **(ii)** 14

Question 5

In order to answer this question correctly it is necessary to realise that the two As are indistinguishable from each other, as are the two Es. Many candidates preferred to find first the probability of the complementary situation where the As are adjacent.

Answer: $\frac{3}{4}$

Question 6

In order to make any progress at all in this question it was first necessary to find the value of P(*B*) using the fact that the events *A* and *B* are stated to be independent. Typically, candidates who understood and used the independence condition experienced little difficulty in completing the question. In contrast a sizeable number of candidates seemed quite unprepared for this topic. Many of the successful candidates found the use of a Venn diagram very helpful.

Answers: $\mathrm{P}(A' \cap B) = \frac{1}{12}$, $\mathrm{P}(A' \cap B') = \frac{1}{6}$

Section B: Mechanics

Question 7

Many candidates obtained the correct distance covered by the stone across the ice. Models of the situation are far more secure and convincing when greater care is taken over the signs/directions of the terms: a correct model here should naturally result in a negative acceleration and so there should be no need to adjust (arbitrarily) the sign 'because it is slowing down'.

Answer: 47.1 m

Question 8

(i) This question is most readily answered by candidates who have a good grasp of the standard model (in terms of U and θ) for projectile motion, and when that is the case, the speed and the maximum height reached can each be found in little more than two lines of work. Sadly, that wasn't always so, and a variety of convoluted approaches were adopted that necessitated far more work and risk of error than was justified by the number of marks available. In addition, a number of candidates used their calculator to find the angle whose sine was given exactly in the question and then found (and used) the sine of an approximation to it.

(ii) As in part **(i)**, thoughtful and knowledgeable use of the standard model leads quickly and easily to the correct result. It is quite acceptable to note that the time of flight is double the time taken to reach the maximum height. It is reasonable to expect candidates to know that if $\sin\theta = \frac{12}{13}$ then $\cos\theta = \frac{5}{13}$.

Answers: **(i)** 26 m s^{-1}, 28.8 m **(ii)** 48 m

Question 9

(i) As in **Question 7**, a carefully constructed model of the situation is the key to success here. The question asked for the acceleration in the ascent stage of the motion and this is necessarily negative. Then a formal application of Newton's Second Law *in the (upward) direction of motion* is expected, from which the magnitude of the resistance can be obtained directly. All too often this was carelessly done resulting in unrealistic answers and/or signs that were ignored or changed because they appeared to be inconvenient.

(ii) For the descent stage a further application of Newton's Second Law, this time in the downward direction, with the resistance now upwards but still opposing the motion, was needed. A significant number of candidates overlooked this and made no worthwhile progress. There were also many attempts where the downward acceleration was obtained in a manner that was, at best, 'hand-waving'.

Answers: **(i)** –11 m s^{-2}, 0.01 N **(ii)** 16.6 s

Question 10

(a) This part was answered easily and correctly by most candidates. The Principle of the Conservation of Momentum seemed to be well known and its application here posed little problem. The use of Newton's Experimental Law also proved to be straightforward enough for most. Any difficulties encountered by candidates were usually a consequence of sign errors at the outset.

(b) While there were many correct answers to this part, it seemed that posing the question in terms of vectors caught out a number of candidates. Beyond that, there needed to be greater care with signs.

Answers: **(a)** λ =5, e = 0.8 **(b)** 4**i** + **j** – 5**k**

Question 11

(i) (a) Most, but not all, sketches were neatly drawn (and without resorting to graph paper). Candidates should be careful not to show both a force and its components in the same diagram.

(b) Good responses were characterised by clear statements of the equilibrium of the situation, resolving parallel and perpendicular to the slope at *A*, vertically at *B* and the condition for limiting friction at *A*. It was then a matter of combining them to eliminate the friction, tension and normal contact forces, substituting the other information supplied in the question and rearranging to find μ. Some very good answers were seen that achieved the required result quickly and efficiently. Statements that unwisely included a mass-acceleration term needed extra care since either '$a = 0$' did not appear subsequently, making the problem intractable or there was a risk of equating expressions that amounted to '0 = 0' from which just about anything could be proved.

(ii) The crucial realisation here was that *A* would accelerate up the slope, with the friction force now acting down the slope, and that *B* would accelerate downwards. Candidates who appreciated this were usually successful. It was not uncommon for candidates to assume the acceleration was in the sense of '*A* down the slope' with the friction still acting up the slope. Similarly for some, one particle (usually *A*) would accelerate while the other would be in equilibrium.

Answers: **(i)(b)** $\frac{1}{8}$ **(ii)** $1.5\,\mathrm{m\,s^{-2}}$